Evaluation of Localized Flux and Loss Distribution in The Corner Joint and T Joint of 1000 kVA Transformer Core

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Kesan ke Atas Fluks dan Kehilangan Kuasa di Sudut Tepi dan Penyambungan T di Dalam Teras Alatubah 1000 kVA

ABSTRAK

Penyelidikan ini melibatkan kerja pengujian dan penilaian keatas teras alatubah 1000 kVA menggunakan bahan GO yang dicampurkan dengan 3% silikon. Pengujian dilakukan keatas tiga model teras alatubah dengan rekabentuk 45° bentuk V di penyambung T dengan tindanan 3mm, 45° bentuk V di penyambung T dengan tindanan dan 90° penyambungan T dengan tindanan 10 mm. Semua teras alatubah menggunakan penyambungan sudut 45°. Pengukuran agihan fluks menggunakan teknik memasang siri lilitan mencari fluks pada permukaan lapisan teras. Pengukuran meliputi variasi secara besaran, arah komponen asas dan harmonik fluks mengikuti arah mudah dan keras bersama dengan komponen fluks arah normal. Pengukuran secara thermometrik dengan cara pengambilan variasi suhu menaik di gunakan untuk mendapatkan nilai kehilangan pada teras tanpa beban. Teras 45° bentuk V penyambungan T dengan tindanan 3mm menunjukkan kehilangan kuasa yang paling rendah jika dibandingkan dengan 2 teras model yang lain pada nilai 0.845 W/kg semasa nilai induksi 1.5T 50Hz. Nisbah perbezaan kehilangan kuasa diantara 45° bentuk V di penyambung T dengan tindanan 3mm dengan teras tindanan 5mm dan 90° penyambungan T tindanan 10mm adalah 1.3% dan 5.79%. Faktor binaan teras untuk untuk tindanan 3mm, 5mm dan 10mm adalah pada nilai 1.11,1.15 and 1.185. Didapati kehilangan kuasa paling tinggi berlaku dilokasi yang mengalami bacaan fluks yang tinggi. Teras T dengan penyambungan dan 90° mempunyai nilai fluks harmonik ketiga yang paling tinggi. Fluks pusaran didapati berlaku di sudut tepi teras tetapi lebih ketara kehadirannya di bahagian penyambungan T teras. Fluks pusaran berlaku dengan nilai fluks keras yang tinggi sekali didalam teras dan 90° penyambungan T mengeluarkan kehilangan kuasa yang paling tinggi pada 0.894W/kg. Kehilangan kuasa yang banyak didapati terletak dibahagian penyambungan tengah teras pada kedua belah bahagian sudut. Perpindahan fluks diantara lapisan teras adalah satu proses yang komplex dimana fluks asas dan normal bergerak dalam masa yang sama. Rekabentuk geometri teras dan jarak tindanan adalah faktor utama untuk mempengaruhi perjalanan fluks secara unifom yang boleh mengurangkan kehilangan kuasa teras. Hasil penyelidikan ini telah menunjukkan bahawa teras 45° bentuk V di penyambung T dengan tindanan 3mm telah mengeluarkan kehilangan kuasa yang paling rendah dan didapati paling efisien. Sekiranya teras ini digunakan didalam system agihan TNB, dijangkakan penjimatan yang boleh dicapai adalah sebanyak RM69.9 juta setahun.

The Effect in Corner Joint and T Joint on Localized Flux and Loss Distribution in 1000 kVA Transformer Core

ABSTRACT

The work involved in this thesis relates to the measurement and evaluation on localized flux and losses distribution in 1000 kVA three phase transformer core using 3% silicon doped Grain Oriented (GO) material. The experiment was carried out on three (3) type of transformer core models namely the 45° V notch T joint with 3mm overlap distance, 45° V notch T joint with 5mm overlap distance and 90° butt lap T joint design with 10 mm overlap distance. Measurement work dealt with variation of the magnitude and directional of the fundamental components as well as the harmonic components. Power loss measurement was conducted using three phase no load loss method. A few array of search coils made up of orthogonal, single turn and normal search coils were used to detect the in-plane and normal flux. Thermometric method adopting variation of temperature rise was selected to capture the power loss. The V notch T joint 3mm overlap design had shown the lowest power loss at 0.845 W/kg at 1.5T 50Hz compared to the V notch T joint 5mm overlap and butt lap 10mm design with difference of 1.3% and 5.79% respectively. Building factor of the V notch 3mm proved to be the lowest compared to the other two design which is at 1.11,1.15 and 1.185. It was noticed highest flux values were concentrated in the inner overlap area of the corner joint. Highest losses are spotted at the same location where highest in-plane flux was presented. The third harmonic flux are highest in the butt lap T joint area. Rotational flux and losses were also detected in corner joint and very significant existence in the T joint area and butt lap design had produced the highest core loss at 0.894 W/kg. Highest core loss is located in the T joint area near both side of the inner corner of the center limb. The flux transfer works between lamination in a complex manner in which a combination of in-plane and normal flux move simultaneously within the laminations. Core geometry design and overlap distance is believed to be the critical factors that can influence the flux flow uniformity which ultimately can reduce power loss in the core. All in all V notch T joint 3mm core design is found to be the most efficient and with optimum performance. It is estimated that a saving of RM69.9 million per year can be achieved if the V notch T joint 3mm core design is utilized in TNB distribution network system.

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